Prevalence of Diabetes Mellitus and Associated Cardiovascular Risk Factors in an Adult Urban Population in Paraguay

J.T. Jimenez[1], M. Palacios[1], F. Cañete[1], L.A. Barriocanal[1], U. Medina[1], R. Figueredo[1], S. Martinez[2], M.V. de Melgarejo[1], S. Weik[1], R. Kiefer[1], K.G.M.M. Alberti*[2], R. Moreno-Azorero[1]

[1]*Institute of Investigations in Health Sciences, Universidad Nacional de Asuncion, Asuncion, Paraguay*
[2]*Human Diabetes and Metabolism Research Centre, University of Newcastle, Newcastle upon Tyne, UK*

A cross-sectional study was conducted on a 20–74-year-old population in an urban white-Hispanic population in Paraguay to determine the prevalence of diabetes mellitus (DM), impaired glucose tolerance (IGT), and associated cardiovascular disease (CVD) risk factors. In total 1606 subjects completed the study (response rate 80.3%; 1094 women, 512 men). The overall prevalences were: DM 6.5 %, IGT 11.3 %, hypertension 17.1 %, and obesity 31.6% with more obesity in women (35.7 % vs 22.8 %, $p < 0.05$). Age-standardized prevalences were: DM 6.5 %, IGT 13.5 % in females and DM 5.5 %, IGT 7.2 % in males. DM and IGT subjects had two or more CV risk factors significantly more often than the normal population. In conclusion, DM, IGT, hypertension, and obesity are common in this South American Hispanic urban population, particularly in women. Public health measures, such as lifestyle education, are required to decrease these non-communicable diseases. © **1998 John Wiley & Sons, Ltd.**

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Introduction

There is a clear trend of an increasing prevalence of diabetes mellitus in developing and rapidly industrializing countries. This may be related to recent changes in lifestyle combined with migration of rural populations to urban areas.[1,2] There are, however, few published studies on the prevalence of diabetes mellitus (DM) and impaired glucose tolerance (IGT) in populations in Latin America. Figures for diabetes range from less than 1 % in the indigenous populations of Chile and Colombia to around 10 % in others.[3–6] Profound and rapid economic and political changes have occurred in recent decades in the South American subcontinent. These have in turn induced very rapid and equally important epidemiological changes. Knowing that the health care costs associated with diabetes and related risk factors are high, health care planning depends on accurate epidemiological data in order to decrease morbidity and mortality related to the disease. We have therefore detrmined the prevalence of DM, IGT, and other cardiovascular disease (CVD) risk factors in the population of the Asuncion-Metropolitan area of Paraguay.

Subjects and Methods

Subjects

This was a cross-sectional study conducted from February 1991 to June 1992 in Asuncion, the capital city of Paraguay and its suburban metropolitan area (population 1 100 000). The target population was adults, 20–74 years old, residing in the catchment area. According to the latest census there were 3.6 adults per house. The initial calculated sample population was 1765. To minimize the possibility of rejection and/or a recruitment bias for familial clustering of diabetes or its risk factors, the sample was increased to 2000 subjects; 53.7 % from Asuncion city and 46.3 % from surrounding towns. Of these, 94 % were of white-Hispanic origin with an admixture of the native indigenous population, and the rest were of other European ancestry.

Study Protocol

Ten local health care facilities were used as bases (Figure 1). From the catchment area of each facility, blocks of

Sponsors: GTZ, German Technical Cooperation in Paraguay
*Correspondence to: Professor K.G.M.M. Alberti, The Medical School, Framlington Place, Newcastle upon Tyne NE2 4HH, UK

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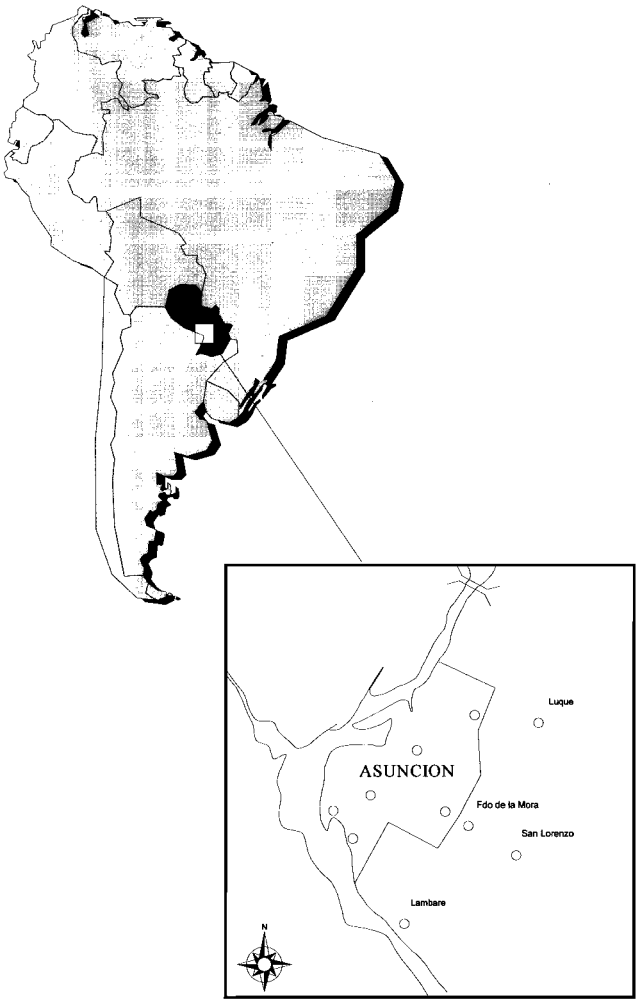

Figure 1. Map of study area and location of health care facilities participating in the study

dwellings were selected at random and every fifth dwelling was visited 48–72 h before the study by a social worker and a psychologist who explained the purpose of the study, risks and benefits. Adults of either gender were invited to participate provided they fulfilled the inclusion criteria: age between 20 and 74 years, not acutely ill, and not pregnant. Persons with cancer or other chronic severe illnesses were excluded. Consenting adults attended the corresponding base facility on Saturdays, early in the morning, after a 12 h overnight fast. A health questionnaire which included personal and family history of diabetes and CV risk factors was completed. Physical activity was assessed as (a) 'sedentary': office workers who do not exercise or do minimal physical activity at home; 'active': industrial and agricultural workers not doing heavy work and occasional exercise; 'very active': those doing unskilled work with regular heavy work and/or regular exercise at home. These criteria are adapted from those of the FAO.

Blood Samples

Fasting venous blood samples were drawn for determination of plasma glucose, total cholesterol, and triglyceride levels. A 75 g oral anhydrous glucose load, dissolved in 300 ml water, was administered and 2 h later another blood sample taken. Subjects who reported diabetes received the glucose load unless they were on oral hypoglycaemic agents or insulin. Specimens were immediately centrifuged to separate plasma, kept cool, transported later to the IICS (Institute of Investigations in Health Sciences) laboratories, and stored at –20 °C until assayed within 1 week of sampling. Diagnoses of DM and IGT were made according to 1985 WHO criteria.[7]

Blood Pressure

Blood pressure (BP) was measured at rest, seated, and at the level of the heart. The average of two blood pressure measurements, taken with an interval of not less than 20 min, using a calibrated mercury sphygmomanometer was recorded. Systolic blood pressure was recorded as the first sound and diastolic as the fifth Korotkoff phase. WHO criteria were used to diagnose hypertension, i.e. systolic BP $\geq$ 160 mmHg and/or diastolic BP $\geq$ 95 mmHg.[8]

Anthropometric Evaluation

Body mass index (BMI) was calculated as weight (kg)/height squared (m^2); body weight was measured with subjects in indoor clothing and height without shoes. In subdividing the groups according to BMI, overweight was taken as $\geq$ 25 and obesity as $\geq$ 30 kg m^{-2}.[9,10] Waist and hip measurements were to the nearest 0.1 cm and the W/H ratio calculated.

Analytical Methods

Plasma glucose, cholesterol, and triglycerides were assayed by standard enzymatic methods.

Statistical Analysis

All statistical analyses were performed using SPSS/PC + software (Chicago, IL). The chi-square test was used to analyse measurements of variables. Student's non-paired *t*-test was used to analyse differences in mean values. All statistical tests were two-tailed. Correlations were tested by multiple regression analysis. Values are expressed as mean ± SD, mean ± SE or geometric mean (95% confidence interval) as indicated; p values $\leq$ 0.05 were considered significant.

Results

The overall response rate was 80.3 %, 1606 subjects completing the study. There were 1094 women (68 %)

Table 1. Prevalence of normal glucose tolerance (NGT), impaired glucose tolerance (IGT), and diabetes mellitus (DM) among males

Age (years)	NGT		IGT		DM	
	n	%	*n*	%	*n*	%
20–29	114	(98.3)	2	(1.7)	0	
30–39	120	(90.2)	7	(5.3)	6	(4.5)
40–49	99	(86.1)	11	(9.6)	5	(4.3)
50–59	64	(74.4)	10	(11.6)	12	(14.0)
≥ 60	50	(80.6)	7	(11.3)	5	(8.1)
Total	447	(87.3)	37	(7.2)	28	(5.5)

and 512 (32 %) in the sample, with females more keen to participate than males, but with no difference in the distribution of participation by gender in each age group.

Tables 1 and 2 show prevalence by age group and gender of normal glucose tolerance (NGT), impaired glucose tolerance (IGT), and diabetes mellitus (DM) in the population studied. Using the whole population as standard, the age-standardized prevalences were: DM 6.5 %, IGT 13.5 % in females and DM 5.5 %, IGT 7.2 % in males. Both DM and IGT were significantly more prevalent among women than men. Overall the results showed 6.5 % DM (2.9 % known and 3.6 % unknown), 11.3 % IGT, 17.1 % hypertension (13.1 % known of whom 52.1 % were on treatment, and 4.0 % previously unknown) and 31.6 % obesity with a significantly higher prevalence of obesity among women compared with men (35.7 % vs 22.8 %; $p < 0.05$). Figure 2 shows prevalence of overweight and obesity by age group and gender. Figure 3 shows prevalence of associated CVD risk factors in NGT, IGT and DM subjects.

Table 3 shows mean values of glucose, lipids, and blood pressure in the normally glucose tolerant (NGT), impaired glucose tolerant (IGT), and diabetic (DM) male and female subjects. Plasma triglyceride and blood pressure values tended to be higher in the IGT and DM subjcts than in those with normal glucose tolerance.

With regard to other risk factors for CVD, smoking prevalence was higher in men (49.4 %) than in women (15.8 %) but a greater proportion of the women had a sedentary lifestyle (45 % vs 28.1 %), which may have contributed to their obesity.

Table 2. Prevalence of normal glucose tolerance (NGT), impaired glucose tolerance (IGT), and diabetes mellitus (DM) among females

Age (years)	NGT		IGT		DM	
	n	%	*n*	%	*n*	%
20–29	218	(96.9)	5	(2.2)	2	(0.9)
30–39	221	(88.8)	21	(8.4)	7	(2.8)
40–49	211	(74.8)	56	(19.9)	15	(5.3)
50–59	157	(71.7)	39	(17.8)	23	(10.5)
≥ 60	68	(57.1)	27	(22.7)	24	(20.2)
Total	875	(80.0)	148	(13.5)	71	(6.5)

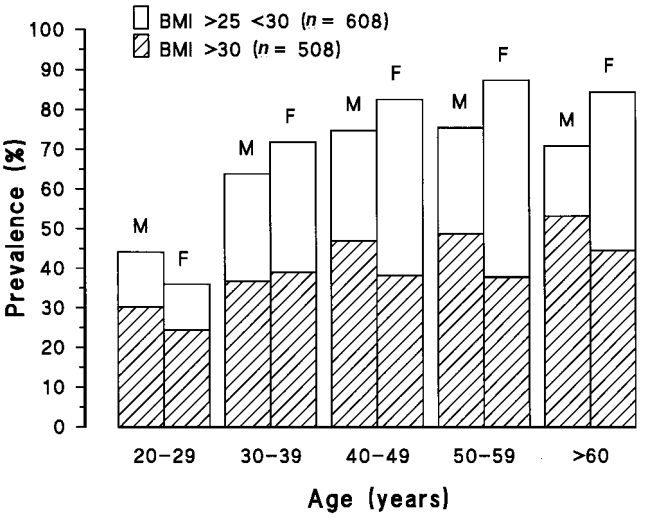

Figure 2. Prevalence of overweight and obesity by age group in male (M) and female (F) populations

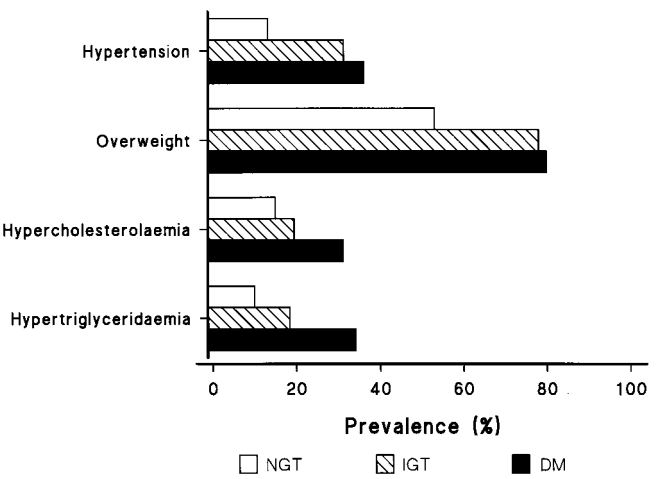

Figure 3. Prevalence of cardiovascular risk factors in normoglucose tolerant (NGT), impaired glucose tolerant (IGT), and diabetic (DM) subjects. Overweight includes overweight and obesity. Hypercholesterolaemia plasma cholesterol ≥ 5.2 mmol l^{-1}. Hypertriglyceridaemia: plasma triglycerides ≥ 1.7 mmol l^{-1}. Hypertension as defined in the text

Discussion

The prevalence of Type 2 (non-insulin-dependent) diabetes mellitus is particularly high in ethnic groups such as Pima Indians, Micronesians Nauruans, migrant Asian Indians, Polynesians, Australian aboriginals and Mexican-Americans/Hispanics.[1,2] In our population there was a relatively high prevalence of both DM and IGT. We have shown a high prevalence in our study in South America, which should be compared with an estimated prevalence of just over 2 % for the total population of South America (Figure 4) and nearly 3 % for Central America.[11] In our study, nearly one in five of the adult

Table 3. Mean values of measured variables in the normoglucose tolerant (NGT), impaired glucose tolerant (IGT), and diabetic (DM) populations

	Male ($n = 512$)			Female ($n = 1,094$)		
	NGT	IGT	DM	NGT	IGT	DM
Age (years)	40.2 ± 0.6	48.3 ± 2.0	49.6 ± 1.8	40.0 ± 0.4	48.9 ± 0.8	53.3 ± 1.4
BMI (kg m^{-2})	26.7 ± 0.8	30.3 ± 0.8	29.5 ± 0.8	27.7 ± 0.7	32.2 ± 0.6	31.1 ± 0.7
WHR	0.91 ± 0.003	0.96 ± 0.008	0.97 ± 0.012	0.81 ± 0.003	0.87 ±0.007	0.88 ± 0.010
Plasma glucose (mmol l^{-1})						
Fasting	5.1 ± 0.02	5.5 ± 0.08	9.5 ± 0.73	5.0 ± 0.02	5.5 ± 0.05	10.7 ± 0.70
2-h post-glucose	5.1 ± 0.06	8.9 ± 0.14	14.9 ± 1.48	5.5 ± 0.04[a]	9.0 ± 0.07	12.3 ± 1.05
Plasma triglycerides (mmol l^{-1})	1.11 (1.04–1.18)[b]	1.83 (1.49–2.26)[c]	1.70 (1.28–2.26)	0.94 (0.90–0.97)	1.38 (1.26–1.51)	(2.05 (1.69–2.47)
Plasma cholesterol (mmol l^{-1})	4.78 ± 0.5	5.47 ± 0.19	5.45 ± 0.24	4.77 ± 0.04	5.31 ± 0.12	5.65 ± 0.15
Blood pressure (mmHg)						
Systolic	123.0 ± 1.2	134.2 ± 1.3	138.0 ± 1.6	121.0 ± 1.3	137.4 ± 1.3	143.1 ± 1.6
Diastolic	77.0 ± 0.8	82.0 ± 0.8	84.0 ± 1.0	75.0 ± 0.8	83.0 ± 0.8	87.0 ± 0.9

Values are mean ± SE except for plasma triglycerides, expressed as geometric mean (95 % CI).
Female NGT subjects show higher levels of 2-h plasma glucose ([a] $p < 0.001$).
Triglyceride levels were higher in male NGT and IGT subjects compared to female NGT and IGT subjects ([b] $p < 0.0001$ and [c] $p < 0.002$, respectively).

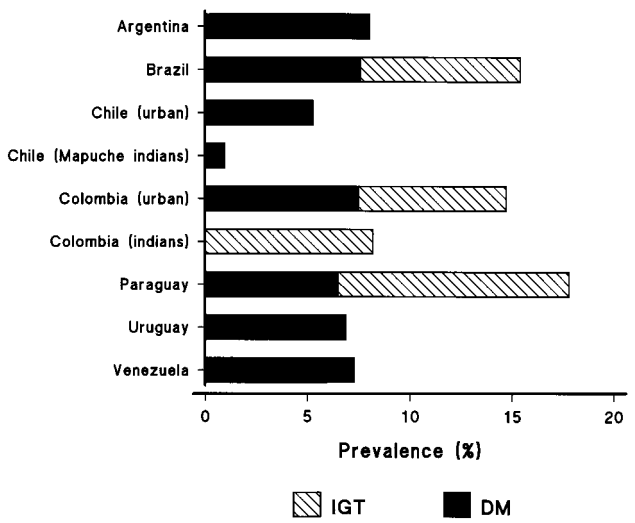

Figure 4. Prevalence of diabetes mellitus (DM) and impaired glucose tolerance (IGT) in Latin American countries

population had DM or IGT, an alarming figure from a public health perspective.

The prevalence of overweight and obesity was strikingly high, independent of the relation with abnormal glucose tolerance. This is probably explained by the sedentary lifestyle in most of the population studied, especially the females. An important finding is that women become overweight at younger ages than men and remain so or move to obesity as they get older.

The high rate of obesity in the female population may be significant, as diabetes confers a greater risk of coronary heart disease in women than in men. Furthermore, a recent study on the influence of obesity and body fat distribution as risk factors for clinical diabetes[12] showed that early obesity, absolute weight gain throughout adulthood, and abdominal adiposity are independent risk factors for diabetes and indirectly therefore for CVD.

The cumulative incidence of CVD risk factors in the IGT subjects found in our study (31 % were hypertensive, and around 35 % had some dyslipidaemia, compared with less than 20 % of the population with normal glucose tolerance) was similar to reported findings in migrant South Asians[13] and newly diagnosed IGT/DM Asian Indians.[14] According to a recently published study on a Japanese population,[15] the magnitude of each coronary risk factor becomes greater in accordance with the severity of glucose intolerance and the plasma insulin levels. It is therefore important to emphasize that the high rate of obesity found in our population suggests strongly that major efforts are needed to avoid an epidemic of diabetes and cardiovascular disease in the near future.

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